The Ecodesign Preparatory Study on Smart Appliances

In the Autumn of 2014, DG Energy launched a 2-year Ecodesign Preparatory Study on Smart Appliances (Lot 33) which will provide an analysis of technical, economic, environmental, market and societal aspects that are relevant for a broad market introduction of smart appliances. This article summarizes the scope and status of this preparatory study.

Keywords: Ecodesign smart appliance

KOEN VANTHOURNOUT
Senior researcher
VITO and EnergyVille
Boeretang 200
2400 Mol
Belgium
Koen.vanthournout@vito.be

SARAH BOGAERT
Project manager
VITO and EnergyVille
Boeretang 200
2400 Mol
Belgium
Sarah.Bogaert@vito.be

One of the basic laws to maintain the stability of the electricity system is that the electricity production must equal the electricity consumption at all times. For this purpose, a wide range of control and planning systems are deployed, operating in different time ranges from milliseconds up to years. Traditionally, it is the production side that adapts to the consumption side. More specifically, it is dominantly the fossil fuel plants that produce less or more in function of the changes in the electricity demand.

This arrangement is increasingly under stress, as the share of renewable and typically intermittent and non-controllable generation is growing. At the same time, environmental and other concerns lead to a decrease in fossil fuel generation. And while the electrification of transport – electrical vehicles – and of heating – heat pumps – allows for a reduced primary energy consumption, the total electricity consumption is further increased as a side-effect. Summarized, the share of flexible electricity production relative to the total electricity demand is decreasing, and therefore new sources of flexibility are required to further ensure the stability of the electricity system.

Those new sources of flexibility can be subdivided into two clusters. A first cluster contains everything energy storage related: batteries, pumped hydro, etc. A second cluster is demand response, which can be considered as the inversion of the traditional control paradigm, i.e., not only adapt the production side, but also adapt the electricity consumption in function of the (renewable) electricity production and/or to avoid grid congestion.

Although there are large differences between the European Member States, in general demand response and demand side flexibility are well-developing in the industrial sector where the large energy consumption of a single installation justifies a customized approach and technical solutions. Most countries have programs that allow automatic adaptation of the electricity consumption of such large energy intensive industrial installations. However, and despite the significant potential, residential demand response is only slowly developing. The cause is what can be described as a "chicken and egg problem": there are virtually no residential demand response programs, because there is not enough capacity available in terms of installed base of appliances with the required functionality. On the other hand, development of appliances with demand side flexibility features is low because there are so little residential demand response products which justify the investment in this extra functionality. Without price signals, capacity fees and/or other rewards, there is no incentive for consumers to buy demand response ready appliances.

To overcome this chicken and egg problem, the European Commission launched several initiatives to stimulate the introduction of residential demand response. One of these is the Ecodesign Preparatory Study on Smart Appliances (lot 33 - http://www.eco-smartappliances.eu). With this preparatory study, the European Commission wants to investigate the technical, economic, environmental, market and societal aspects that are relevant for a broad

market introduction of smart appliances in residential and commercial sectors and the policy instruments that can stimulate a wide roll-out of smart appliances in Europe. The study is being executed by an expert consortium composed of VITO, Viegand Maagøe, Rheinische Friedrich-Wilhelms-Universität Bonn, MINES ParisTech and Wuppertal Institute. The effective start was in the autumn of 2014 and the study is expected to be finished in September 2016.

Smart appliances?

From the start of the study, it became clear that 'smart appliances' is a term with many domain dependent meanings. In its broadest interpretation, it is any appliance that is internet connected and for which a cloud application exists (see **Figure 1**). The preparatory study, however, approaches smart appliances from the very specific angle of the electricity domain. Hence, for the purpose of the lot 33 preparatory study **a smart appliance is defined as an appliance that provides Demand Side Flexibility**:

- It is an appliance that is able to **automatically** respond to external stimuli e.g. price information, direct control signals, and/or local measurements (mainly voltage and frequency);
- The response is a **change** of the appliance's **electricity consumption pattern**. These changes to the consumption pattern is what is called the 'flexibility' of the smart appliance.

The study focusses on the smart appliances and the potential flexibility generated, independent of how this flexibility is used in a specific energy market structure. The range of demand response business cases and energy markets that can be supported should be as wide as possible, but market design self, i.e. what market structure or business cases are to be preferred, is out of scope.

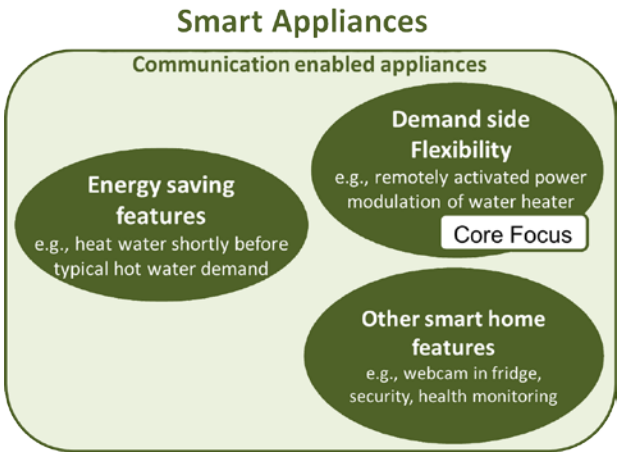

Figure 1. Various functionality classes associated with smart appliances, with the functionality class highlighted that the preparatory study is focusing on, i.e., demand side flexibility.

Lot 33: a horizontal Ecodesign study

The Ecodesign Directive [1] establishes a framework to set mandatory ecological requirements for energy-using and energy-related products sold in all 28 Member States, with the purpose of reducing the energy consumption and other negative environmental impacts. These Ecodesign requirements may be complemented with mandatory labelling requirements [2].

Typical Ecodesign preparatory studies focus on the energy efficiency of a single product group, and do so according to the Methodology for the Ecodesign of Energy-related Products ("MEErP") [3]. However, the Preparatory Study on Smart Appliances is atypical and deviates from this default approach. It focuses on demand response flexibility, which indirectly supports energy efficiency, as it provides functionality that allows the electricity grid to support a larger share of renewable production and more electrified energy-efficient appliances. Hence, environmental and economic impacts are calculated at the level of the overall energy system, not (only) the product itself. Secondly, it also adopts a horizontal approach, meaning that it takes a broad range of product groups into consideration, rather than a single one. The MEErP has been designed mainly for specific and homogenous product groups. Despite this, the study follows it where possible.

Appliances in scope of the study

The focus of the preparatory study on smart appliances is the demand side flexibility of residential end devices. 'End device' means the appliance that is controlled and that alters its electricity consumption, as opposed to the equipment higher up in the control chain (devices that control other appliances or end devices).

The end devices within the scope of the study are listed in **Table 1**. These product groups have been categorized based on their potential, which was analyzed based on the product-specific end-use parameters and user requirements, daily and seasonal use patterns, comfort constraints and expected flexibility.

Out of these categories, following product groups were selected for further in depth study:

- Washing machines
- Tumble dryers
- Dishwashers
- Refrigerators and freezers

- Commercial refrigeration products
- Water heaters (continuous)
- HVAC heating in residential and tertiary buildings (electric heating)
- HVAC cooling in residential and tertiary buildings (air conditioning)
- Residential energy storage systems

The study will further focus on the functionality that is required to achieve **demand response readiness** of the appliances. An example of such functionality is, for instance, the ability to remotely switch air conditioners on or off within the boundaries of the user's comfort settings.

A second focus is the **interoperability** of smart appliance, i.e., what is required to ensure that smart appliances can be used 'plug and play' throughout the E.U., without risk of customer lock-in.

Table 1. The appliances within scope of the preparatory study, divided into three categories; 'high potential': high flexibility potential with few comfort and/or performance impacts, 'medium potential': smaller flexibility potential and/or larger comfort/hetalth impacts, and 'low/no potential': only emergency flexibility potential.

High potential	Medium potential	Low/no potential
Washing machines	Refrigerators/freezers	Electric water heater (instantaneous)
Dishwasher	Battery operated rechargeable appliances (smart phone and tablets)	Battery operated rechargeable appliances (others)
Washer-dryer	Tumble dryer	Vacuum cleaners
HVAC (radiators, boilers, heat pumps, circulators, residential and non-residential air conditioners)	HVAC (extraction fans, heat recovery ventilation and air handlings units)	Range hoods
Buffered electric water heater		Lighting
Battery storage systems		Electrical hobs
		Ovens

Current status and next steps

A stakeholder consultation process has been set up and all deliverables are available via the website http://www.eco-smartappliances.eu. The site also provides information on the procedure and timeframe for written comments. A first stakeholder meeting, held on 10 March 2015 in Brussels, was dedicated to introducing the scope, objectives and structure of the Preparatory Study, and included discussions on the products' scope, and the standardization and interoperability issues. The final MEErP Task 1 report of the study, which defines the scope, has been published in December 2015.

During a second stakeholder meeting on 19 November 2015, the draft reports of MEErP Tasks 2-4 were discussed, containing respectively an economic and market analysis for smart appliances, the impact study of smart appliances on the user and a technical analysis of the existing products and the state of the art.

Currently, model calculations are being executed to assess the economic and environmental value of the flexibility provided by smart appliances for the electrical energy system. Draft results are expected to be published in the next months. The next stakeholder meeting to discuss these results is expected to take place before Summer. The study is expected to finish by the end of September 2016. ■

References

[1] Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products. http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32009L0125.

[2] Directive 2010/30/EU of the European Parliament and of the Council of 19 May 2010 on the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products. http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32010L0030.

[3] Methodology for the Ecodesign of Energy-related Products (MEErP). http://ec.europa.eu/growth/industry/sustainability/ecodesign/